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**COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN
PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL
COMMITTEE, THE COMMITTEE OF THE REGIONS, AND THE EUROPEAN
INVESTMENT BANK**

Accelerating Clean Energy Innovation

1. INTRODUCTION

Accelerating the transition to a low-carbon competitive economy is both an urgent necessity and a tremendous opportunity for Europe.

It is a central challenge of our time. Failure may put our welfare at stake. Success would open unprecedented economic opportunities and new avenues to prosperity, welfare and growth.¹

The European Union is well placed to lead this transition, which received new momentum and direction from the Paris Agreement.² Europe has spearheaded global efforts to fight climate change, has been a driving force in developing renewables, and leads the world in energy-efficiency solutions for industry, transport, buildings. Europe's businesses have built a comparative advantage in many world markets – where competition from global competitors is growing – and European scientists and innovators are pushing the frontiers of knowledge.³

Based on these strong foundations, the Commission is presenting a package of legislative measures to lay out a clear framework for action, based on three overarching goals:

- Energy efficiency first
- Europe as the global leader in renewables
- A fair deal to consumers

Europe needs to step up its investment in energy efficiency and renewable technologies, and the development of clean energy business models, embracing the new opportunities and consumer empowerment brought about by digitisation.

As set out in the Clean Energy for All Europeans⁴ Communication, innovation is one of the key areas where concrete action can be strengthened in the short term, refocused and the synergies improved to support jobs, growth and investment in Europe. The core investment has to come from the private sector. But the European Union can and should play a decisive role. This Communication lays out a comprehensive strategy for the three main policy levers the EU can deploy to boost private investment in clean energy innovation.

- The EU can set the political ambition and create the right business environment through targeted signals, policies, standards and regulations. This is about setting strong and consistent incentives for private investment in clean energy research, development and deployment. EU-level policy and regulatory frameworks need to

¹ Global market projections for low-carbon and energy-efficient solutions range from about EUR 1,600 billion to EUR 4,400 billion per year, with high growth potential especially outside Europe.

² See, *The Road from Paris*, COM(2016) 110 final.

³ Europe is the leader for high-value patents in climate change mitigation technologies. See, *Scaling up innovation in the Energy Union to meet new climate, competitiveness and societal goals* (i24C, 2016), p.35.

⁴ [COM\(2016\)860](#)

prioritise energy efficiency, set a high ambition for global leadership in renewables, and place the consumer at the centre of the energy system.

- The EU can also deploy targeted financial instruments to lower the risk of private investments in untested but promising clean energy technologies or business models. This is about using public loans, equity investments and financial guarantees in projects that are unlikely to find full funding from the private sector due to market, technological or scientific uncertainty. With these EU instruments, as demonstrated by the Investment Plan for Europe⁵, the risk for the private sector is reduced, enabling private investment that otherwise would fail to happen;
- The EU can focus its research and innovation funding, in particular through Horizon 2020, to push the frontiers of science and knowledge. This is about funding curiosity-driven research, mission-oriented research and demonstration projects in order to encourage and accelerate the transition from the lab to successful goods and services that create jobs and generate growth.

In addition to these three categories of action, the Union has an important role in engaging in international initiatives on clean energy innovation, and enabling coordinated efforts with cities, regions and Member States.

This strategy explicitly serves two core political priorities of the European Union: building a resilient Energy Union with a forward-looking climate change policy – of which it is a core deliverable – and giving a new boost to jobs, growth and investment. At its heart lies a co-ordinated effort to promote and develop enabling technologies, services, business models, and social innovation, thus contributing to growth and employment and making EU industries more competitive in world markets. In doing so, the strategy also will serve as test-bed for future horizontal approaches to boost innovation and competitiveness in the EU.

2. AN ENERGY SYSTEM IN TRANSITION

The energy system has reached a tipping point. Renewables are increasingly cost-competitive and account for growing shares of electricity generation. Energy intensity rates – measuring energy use in relation to economic output – are falling, particularly in developed economies. The EU can take much credit for these successes, although much more remains to be done. Its leading role in battling climate change has made European industries the most energy-efficient in the world, and turned them into global innovation leaders churning out new technologies, materials, and solutions. From the start, the EU's climate and energy policy has followed a holistic design, aimed to coordinate investments by the EU, Member States, and industry, as well as to align relevant policy and regulatory frameworks.

Further progress will require even greater efforts. There is a need for new solutions for energy storage, and developing a broader portfolio of cost-effective renewable technologies. Similarly, there needs to be a much faster adoption of existing energy-

⁵ COM(2014) 903 on the Investment Plan for Europe

efficiency technologies across building stocks, transportation systems, and manufacturing practices. The recently updated Strategic Energy Technology Plan plays an important role in this respect⁶.

More fundamentally, the transition to a low-carbon, energy-efficient and climate-resilient economy will require a more decentralised, open system with the involvement of all society. The energy system has traditionally been marked by the dominance of large companies, incumbents and large-scale, centralised technological projects. But in future the consumer has to be at the centre of the energy system: demanding competitive low-carbon solutions; participating as producer and manager of decentralised energy networks; acting as an investor, through decentralised platforms; and driving change through user innovation.

A more bottom-up, user-centred energy system is a driver for more innovation. And at the same time, this decentralisation is made possible thanks to other innovations, chief among them the digitisation of core aspects of the energy market and transport system. Today, and even more tomorrow, digitisation means lower barriers to entry. This means that the consumer, the local community and the small start-up can all participate and even lead in the development of energy innovations.

Fostering low-carbon innovations, energy efficiency projects and renewables requires a system of open innovation. Companies and industries increasingly understand that the complexity of today's world means that no single entity can come up with a complete solution. Furthermore, the most interesting market-creating innovations are happening at the intersection of different sectors, disciplines and approaches⁷.

3. POLICY SIGNALS AND REGULATORY FRAMEWORKS

Clean-energy innovation requires a well-functioning single market and a robust competition policy, which gives newcomers an opportunity to bring their innovations to the market on equal footing with incumbents. Completing the Capital Markets Union⁸ will mean more opportunities for cross-border flows of capital and a greater emphasis on sustainable finance using instruments such as green bonds. This means more funding opportunities for innovative projects in the area of energy efficiency and renewables. A greater emphasis on open innovation and open science will lead to more opportunities, especially for smaller companies, to bring research results to the marketplace.⁹

⁶ C(2015) 6317 final on Towards an Integrated Strategic Energy Technology (SET) Plan: Accelerating the European Energy System Transformation

⁷ In the EU's energy system, innovation is not only about new technologies, but also new disruptive business models and services, societal innovation and new policy and financial mechanisms. See, Scaling up innovation in the Energy Union to meet new climate, competitiveness and societal goals (i24C, 2016), p. 14.

⁸ COM(2016) 601 final on Capital Markets Union - Accelerating Reform

⁹ See Open innovation, open science, open to the world, 2016, European Commission, ISBN 978-92-79-57346-0.

In addition to these broad pre-requisites for a better innovation ecosystem, the acceleration of clean-energy innovation will require important changes in energy subsidies and energy-specific regulations.

The remaining but still significant policies benefiting oil, coal and other carbon-intensive fuels, including subsidies by some Member States, should be seen as an obstacle to clean-energy innovation. These policies mask the true societal cost of fossil fuels and artificially lower their prices. This makes life harder for innovative clean-energy projects which then have to face harsher market conditions.

These policies are in direct contradiction to EU commitments under the Paris Agreement, and in the context of the G20 and the G7. The Commission's report *Energy prices and costs in Europe*,¹⁰ issued together with this Communication, finds that in 2012 annual direct fossil-fuel subsidies stood at around €1.9 billion, rising to €300 billion when including environmental externalities. In a context of scarce resources, the fiscal burden of these subsidies means that fewer resources can potentially be devoted to public funding for clean-energy research and innovation. In Europe, for 2014, such funding amounts to €4.2 billion by the 28 EU Member States. EU instruments also support clean-energy innovation, for example through the €1.1 billion from the EU's Horizon 2020 program. Redirecting only a fraction of the €1.9 billion of direct fossil-fuel subsidies would therefore have a big impact.

Promoting renewable energy technologies is a central plank of the EU's global leadership of the clean technology transition. The Electricity Market Design Directive¹¹, in conjunction with strengthened carbon prices, aims to create a market fit for renewables which would reduce the need for specific support schemes. This would allow to progressively focus public support on less mature renewable electricity technologies and complement research and innovation efforts by market pull instruments for those technologies.

The time is ripe for change. Current low oil and gas prices provide a window of opportunity for phasing out fossil fuel subsidies without adverse effects on social welfare.

According to Organisation for Economic Co-operation and Development and International Energy Agency figures, a significant share of subsidies result from preferential tax treatments of fossil fuels, something the Commission is examining in the context of the wider reflection on energy taxation in the EU.

In the Communication "Clean Energy for All Europeans"¹², the Commission sets out a range of actions to help redirect financial flows towards the clean energy transition, including measures to reinforce transparency on the issue of subsidies and their effect on innovation.

Creating the right market conditions for innovation includes putting in place a stable, long-term, transparent and predictable regulatory environment. In May 2015, the Commission

¹⁰ SWD(2016) 420

¹¹ COM(2016)864

¹² COM(2016)860]

presented the revised Better Regulation package¹³, recognising that innovation needs to be thoroughly considered in any new legislative proposals. This has been stressed in recent Council conclusions referring to the “innovation principle”¹⁴. Furthermore, standards, as well as the marketing of innovative energy technologies¹⁵ matter greatly as well.

Regulation can accelerate the emergence of innovative low-carbon technologies and act as a spur for greater competitiveness, facilitating the emergence of better-functioning, sufficiently large markets and greater policy certainty. The Commission is putting forward, together with this Communication, a broad package of legislative and non-legislative measures under the Energy Union. These measures will provide a clear framework for the uptake of the innovations that are needed to achieve the objective of the competitive low-carbon economy. For example, the redesign of the European electricity market will support the penetration of renewable-energy sources, allow for effective demand management, and unlock regionally integrated energy markets; the Energy Performance of Buildings directive¹⁶ will create incentives for the development of innovations to achieve a European building stock of nearly-zero-energy houses and deliver energy-plus districts by 2050; and the revised Renewable Energy Directive (RED II) will, inter alia, spur the development of the next generation of renewable-energy solutions in the heating and cooling, transport and electricity sectors.

Existing Commission proposals to review the EU Emission Trading System (ETS)¹⁷, the Effort-Sharing Regulation¹⁸, as well as the proposal for the integration of Land Use, Land Use Change and Forestry (LULUCF)¹⁹ into the overall effort to reduce the greenhouse gas emissions will likewise stimulate low-carbon innovation. The action plan for the Circular Economy²⁰ will contribute to increasing energy efficiency and reducing emissions by better using raw materials and recycling secondary raw materials and waste. The corresponding role of the bioeconomy will be considered in the upcoming review of the bioeconomy Strategy and its possible update. The decarbonisation of transport will act as an additional "pull" factor for innovation. The recent Communication on a European Strategy for Low-Emission Mobility²¹ contains an action plan to facilitate the transition to low-emission mobility and provide new opportunities for innovation, job creation and for reducing Europe's energy dependency.

Finally, public procurement can and should serve as a further powerful instrument to create markets for innovative products. European standardisation can further support green public procurement for innovative products, helping public authorities in the development

¹³ COM(2016) 615 final on Better Regulation: Delivering better results for a stronger Union

¹⁴ Competitiveness Council Conclusions, May 2016.

¹⁵ The Environmental Technology Verification provides third-party verification of technology performance. See <http://ec.europa.eu/environment/ecoap/etv/>

¹⁶ DIRECTIVE 2010/31/EU of the European Parliament and the of the Council of 19 May 2010 on the energy performance of buildings

¹⁷ COM/2015/0337 final - 2015/0148 (COD)

¹⁸ COM/2016/0482 final - 2016/0231: Effort sharing Regulation

¹⁹ COM(2016) 479 final 2016/0230 (COD)

²⁰ COM/2015/0614 final on Closing the loop - An EU action plan for the Circular Economy.

²¹ COM(2016) 501 final

of the required technical specifications. As mentioned in the Start-up and Scale-up Initiative²², in 2017 the Commission will introduce measures on EU procurement to amongst other things encourage Member States to set ambitious innovation buying targets.

Policy signals and regulatory frameworks – Proposed actions:

- The Commission will also examine, when reviewing the guidelines on State aid for environmental protection and energy 2014-2020 how those rules, together with the State aid rules for research & innovation investments, enable Member States to stimulate innovation in renewable energy technologies and solutions.
- In the Communication "Clean Energy for All Europeans", the Commission sets out a range of actions to help redirect financial flows towards the clean energy transition, including measures to reinforce transparency on the issue of subsidies and their effect on innovation.
- Upcoming legislative proposals relevant to clean energy and climate action, amongst others the revision of the post-2020 strategies on cars/vans and on lorries, buses and coaches,²³ will be subject to an in-depth analysis of their impact on research and innovation.
- Future annual Union work programmes for European standardisation will target Energy Union priorities, notably the decarbonisation of the economy and support for green public procurement.²⁴
- The Commission will examine options to boost market uptake of innovative clean energy solutions through public procurement, including in the context of the revision of the Clean Vehicles Directive (Directive 2009/33/EC), and through the further development of voluntary green public procurement criteria.

4. FINANCIAL INSTRUMENTS TO BOOST PRIVATE-SECTOR INVESTMENT

To build a competitive low-carbon economy, Europe needs to mobilise substantial amounts of investment²⁵. In 2014, private investments in Energy Union research and innovation priorities are estimated to have reached 22.9 billion euro in the EU. While this number represents an increase compared to previous years, such growth should take place at much faster pace in order to achieve our objectives.

The EU disposes of an array of different funding and financial instruments to support low-carbon innovation. These cover the whole innovation value-chain, from research & development to deployment of mature technologies. As highlighted in the Communication "Clean Energy for All Europeans", in the coming years it will be essential to boost additional investments in the deployment of mature renewables and energy efficiency solutions. To do so, it is important to use public support to improve the risk profile of key projects, ensure greater visibility and easier and more streamlined access and blending opportunities for project developers, in line with the horizontal efforts already undertaken

²² COM(2016) 733 final

²³ See, *Commission Work Programme 2017, Annex I, COM(2016)710 final*),

²⁴ See, *COM (2008) 400*.

²⁵ See World Energy Outlook, 2016

in the context of the Investment Plan for Europe. The European Fund for Strategic Investments is the key instrument in this regard: already more than 25% of its current investments in more than 40 projects are leveraging finance in the Energy and Environment and resource efficiency priority sectors, representing an estimated amount of triggered investments of up to EUR 30 billion. Building on the success of the European Fund for Strategic Investments²⁶ within its first year of operation, the Commission has proposed to extend the duration of the European Fund for Strategic Investments until the end of 2020 and to require that at least 40% of projects in the European Fund for Strategic Investments infrastructure and innovation window should contribute to climate, energy and environment action in line with the COP21 objectives.²⁷ In addition, financial instruments are also available through the European Structural and Investment Funds. Member States and regions have already planned investments for low-carbon (EUR 6 billion) and for innovation (EUR 5 billion) over the 2014-2020 period.

In order to accelerate clean energy innovation, there is however also a need to go beyond the deployment of mature technologies and use public resources to support breakthrough technologies and address gaps in private financing at earlier stages of the innovation cycle. New investments have to target the critical stage of scaling up low-carbon, energy-efficient solutions, taking them from the demonstration stage to the market. This stage typically requires high levels of investment but the remaining uncertainties regarding cost, performance and market integration create too high a risk for private-sector investors.

First-of-a-kind, commercial-scale demonstration projects present a particularly high risk for private sectors. To address these types of projects, the European Commission, together with the European Investment Bank (EIB) last year launched the Energy Demonstration Projects²⁸ facility as part of Horizon 2020 InnovFin. The Energy Demonstration Projects is generating strong interest for loans or loan guarantees to first-of-a-kind low-carbon technologies in renewables and fuel cells and hydrogen.

The Commission seeks to leverage EU public funds through mobilising private investments. The Commission proposal on the revision of the EU Emission Trading System is putting forward an Innovation Fund as a successor to current NER 300 facility. Swift implementation of the Innovation Fund should support investments into highly innovative low-carbon technologies for energy-intensive industries, as well as for renewable energy and Carbon Capture, Storage and Use. All these efforts will require strong linkages with other EU instruments, particularly InnovFin Energy Demonstration Project, the European Fund for Strategic Investment and the European Structural and Investment Funds. The future Emission Trading System Innovation Fund should support investments in low-carbon innovation in renewable energy; carbon capture, storage and use; and in energy-intensive industry. The Commission also has proposed enabling the start of the Innovation Fund before 2021.

²⁶ COM(2014) 903 on the Investment Plan for Europe.

²⁷ COM(2016) 581 final

²⁸ Regarding The Energy Demonstration Projects, see <http://www.eib.org/products/blending/innovfin/>

The Commission and the European Investment Bank will set up a Cleaner Transport Facility to support the deployment of alternative energy transport solutions. EIB financial products and advisory services will be made available to public and private entities. Projects may also be eligible for the Connecting Europe Facility or the European Fund for Strategic Investment guarantee.

To achieve scale and maximise impact from European Fund for Strategic Investment and other financial instruments, there needs to be a strong pipeline of innovative projects that reach investment and market readiness. In the framework of the European Fund for Strategic Investment the Commission has developed the European Investment Project Portal²⁹ that aims to build a bridge between the EU project promoters and investors worldwide. The Portal offers visibility to the project promoters seeking potential investors, and access to a transparent pipeline of viable projects within the European Union and an easy access to the project developers and promoters to investors.

In addition, research Public-Private Partnerships such as the Joint Technology Initiatives on Fuel Cells and Hydrogen, CleanSky, the Single European Sky Air Traffic Management Research, Shift2Rail, and the BioBased Initiative, as well as contractual Public-Private Partnerships, e.g. Green Vehicles and Sustainable Process Industry through Resource and Energy Efficiency, represent an important source of new investment, resulting from Research & Development co-financed with industry, and provide a project pipeline. Another key source of new clean energy investments and subsequent project proposals that are ready for EU financing will come from the Knowledge and Innovation Communities, in particular the Knowledge and Innovation Communities-InnoEnergy and the Climate-Knowledge and Innovation Communities. The Knowledge and Innovation Communities are instrumental in connecting European sources of Research & Innovation funding, such as Horizon 2020 and the European Structural and Investment Funds³⁰, with private partners and bridge regional and local activities to enterprises, start-ups and Small and Medium Enterprises. Their work will be extended to advisory services on access to capital, technical assistance or business models proposals.

Financial Instruments to boost private investment – Proposed actions

- The European Commission is working towards at least doubling the budget of the InnovFin Energy Demonstration Projects scheme, as well as expanding its scope, using funds channelled from different sources including Horizon 2020, the European Fund for Strategic Investment and other instruments. Synergies with other instruments are being developed, aiming for a one-stop advisory facility to orient potential investors and developers among the different instruments available.
- The Commission and the European Investment Bank will set up a Cleaner Transport Facility to support the deployment of alternative energy transport solutions. To build a project pipeline, targeted collaboration initiatives, such as the new deployment initiative for clean (alternatively fuelled) buses, will be promoted.
- The Commission, through the European Investment Project Portal and other channels, will

²⁹ The European Investment Project Portal: www.ec.europa.eu/eipp

³⁰ Regulation (EU) No 1303/2013

bring a pipeline of innovative projects to the attention of investors of the relevant Public Private Partnerships supported under Horizon 2020 and the Knowledge and Innovation Communities InnoEnergy and Climate of the European Institute of Innovation & Technology.

5. FUNDING ENERGY SCIENCE AND TECHNOLOGY AND ITS MARKET ADOPTION

The European Union is one of the global leaders and largest public funders of clean energy research and innovation. Horizon 2020 includes an allocation of 5.7 billion euro for the societal challenge 'secure, clean and efficient energy'. Combined with other areas of Horizon 2020, over €10 billion in energy funding is dedicated to clean energy research and innovation.

This is complemented by significant investments from the European Structural and Investment Funds, including via the smart specialisation strategies.³¹ Engaging industry, researchers and public authorities, smart specialisation strategies serve to focus Member States' financial support in potential high-growth areas, such as low-carbon energy.

Building on this success, expanding the frontiers of science and knowledge is a necessary condition for ensuring the quality and impact of future European investments towards the low-carbon economy. This is addressed through various elements of Horizon 2020:

Fundamental research: Horizon 2020 will continue to fund ground-breaking fundamental research through the European Research Council³² which follows a bottom-up approach in the calls for proposals. Since 2007 the European Research Council has awarded 248 grants to research projects in the area of energy, amounting to roughly €500 million of EU funding.

Market-creating innovation: As a new measure to be introduced in the remaining period of Horizon 2020, the Commission will consider creating a European Innovation Council³³ to contribute to generating breakthrough innovations that can capture and create new markets. Placing particular emphasis on start-ups and Small and Medium Enterprises, this potential European Innovation Council would complement the proposed Start-up and Scale-up initiative.³⁴ The aim is to improve the likelihood of capturing, supporting and scaling up the most interesting examples of market-creating disruptive innovations in Europe, in a bottom-up and interdisciplinary manner – including at the intersection of energy, transport and digital technologies. A first set of measures will be introduced in 2017 under Horizon 2020 and the Commission will look to strengthen this approach in future programmes.

Mission-driven research and innovation: the Commission will explore new approaches inspired by best practice internationally. This includes approaches that combine a

³¹ <http://s3platform.jrc.ec.europa.eu/>

³² Regarding the ERC <https://erc.europa.eu>

³³ Working title

³⁴ See, Communication on Europe's next leaders: the Start-up and Scale-up Initiative, COM(2016) 733 final

directive, mission-driven way of identifying and selecting projects with high potential impact; direct involvement in the day-to-day management of the project and various forms of targeted, tailor-made assistance; as well as powers to restructure or terminate funding if agreed milestones are not reached (exemplified by the United Kingdom's Catapult program or the United States Advanced Research Projects Agency-Energy).

Inducement prizes: The Commission will use inducement prizes as a bottom-up instrument to deliver break-through innovations, giving contestants complete freedom to devise the most effective solutions. This builds on experience so far in Horizon 2020 (€8.25 million for five on-going clean energy prizes).

In addition to the focus on clean energy research and innovation, delivering this Communication will require to involve other areas:

Climate research: Horizon 2020 is supporting research that will feed into the upcoming 2018 Report by the International Panel on Climate Change. This report will present the research findings on the 1.5°C global warming scenario and will undoubtedly bring a sharper focus to the EU's own efforts going forward. In this context, a European Decarbonisation Pathways Initiative, steered by a High-Level Panel, will develop science under Horizon 2020 to help identify feasible and credible pathways compatible with the Paris Agreement.

Space research: Horizon 2020 is supporting research to provide Europe with a global capacity to monitor anthropogenic carbon dioxide emissions.

Transport research: Horizon 2020 supports the decarbonisation of the transport system, by advancing the energy efficiency of vehicles, electromobility and battery technologies, shifting towards environmentally friendly mobility solutions, and driving digitisation for more efficient transport and mobility. The activities will promote the emergence of new business models and innovation-friendly standards and regulations, in particular in urban areas. R&I action will complement ongoing policy action to support roll-out of mature innovative technologies, such as in zero-emission public transport or intelligent transport systems.

Social sciences and humanities: To deepen understanding of behavioural or other socio-economic conditions related to social acceptance of – or opposition to – climate and energy-related policies, the Commission is putting in place a new energy-research platform. Bringing together energy specialists from the social sciences and humanities as well as more technical fields and reaching out to all regions of Europe, the platform will give a much-needed boost to interdisciplinary and cross-sector work. It will work to better exploit the immense potential for social innovation in the energy field, as well as to overcome existing societal barriers, in view of making suggestions to European policymakers in support of delivering the objectives of the Energy Union.

Examples of European clean energy innovation projects supported by Horizon 2020:

1. The InnovFin Energy Demo Project Facility has provided a €10 million loan for a first-of-a-kind full scale demonstration project for the WaveRoller concept of Finnish company AW-Energy. The project aims to bridge the gap between demonstration and commercial deployment of wave energy conversion into electrical power, which shows high global market potential.
2. The European Investment Bank has provided a quasi-equity loan of €20 million under the InnovFin Midcap Growth Finance program to Heliatek from Germany. The company invented and patented a unique technology to produce electricity-generating solar films (Heliafilm®), using organic photovoltaics (OPV) which can be integrated in glass or façade elements, or can be applied to rooftops.
3. The ELIPTIC (Electrification of public transport in cities) project has received € 6 million from Horizon 2020 for exploring ways to electrify urban public transport systems, by optimising the use of existing infrastructure in European cities - making public transport the backbone of electric mobility, thus leading to reduced fossil fuel consumption and improved air quality.

In order for Europe to become a leader in renewables, key bottlenecks that need to be addressed are the integration of renewables into the energy system, as well as developing advanced storage solutions to ensure a stable energy supply for households and industry. Furthermore, to make a major step in implementing the energy-efficiency-first principle, the decarbonisation of the EU's building stock must be tackled, as it is responsible for over 40% of the EU's final energy demand. In addition, the transport system poses enormous potential to cut carbon dioxide emissions, but to do so it requires storage solutions and digital innovation to support transport and smart mobility services.

Strong prioritisation can contribute to creating sustained impact and capitalise on opportunities to lower carbon dioxide emissions, raise industrial competitiveness and exploit export opportunities. This requires a focus on those innovations that enable higher penetration of renewable energy technologies and greater energy savings; have direct relevance to citizens by allowing their participation in the energy transition or by making it more affordable. Building on the progress already achieved under the Integrated Strategic Energy Technology Plan, the Commission intends to focus future funding available under Horizon 2020 more clearly on four interconnected strategic priorities, all relying on digitalisation as key driver:

1) Decarbonising the EU building stock by 2050: From nearly-zero energy buildings to energy-plus districts: As pointed out in the Commission's European Buildings Initiative,³⁵ buildings are an essential part of Europe's clean energy transition. While the EU is already a global leader in innovation systems for buildings, research and innovation in this field must remain a top priority in order to further expanding on this leadership in the future. The EU's building stock represents a total floor area of around 25 billion m².³⁶ Buildings consume 40% of the EU's final energy demand, more than any other sector. But buildings also represent a large energy-savings potential and once renovated and upgraded (ensuring the consideration of embodied energy), they can help to generate extra renewable-sourced power or provide key energy storage capacity.

³⁵ COM(2016) 860 Annex I

³⁶ See, *Europe's buildings under the microscope* (2011).

2) Strengthening EU leadership on renewables: Further system integration and developing the next generation of renewable-energy technologies, including potential game-changers, is required for renewables to become the dominant source of primary energy production and power generation.³⁷ It is also a prerequisite for the transformation of carbon-intensive sectors, such as transport, where strong incentives to innovate in alternative energy forms (e.g., electricity from renewable sources, advanced biofuels and other synthetic fuels derived from the use of carbon dioxide and other re-used greenhouse gases) are needed. This includes dedicated research and innovation support, in close collaboration with industry, for Europe to maintain its global leadership in renewable-energy technologies.

3) Developing affordable and integrated energy storage solutions: To facilitate and enable the transition to a low-carbon energy system (including transport) based largely on renewables, the EU needs to accelerate the full integration of storage devices (chemical, electrochemical, electrical, mechanical and thermal) into the energy system, at domestic, commercial and grid scale.³⁸

4) Electro-mobility and a more integrated urban transport system: Rapid development and deployment of next-generation electric vehicles based on advanced battery designs and new powertrains, an innovative recharging infrastructure and associated business models and services are key elements of the future low-carbon mobility, along with a more integrated urban transport system using new digital technologies and the European Global Navigation Satellite Systems to improve energy efficiency.³⁹

The impact of Horizon 2020 in these four interconnected strategic priorities will be further enhanced through synergies with the related investments of the European Structural and Investment Funds.

Funding energy science and technology and its market adoption – Proposed actions

To reach the goal of making the EU the world leader in clean energy solutions, funding from the EU budget needs to focus on disruptive innovation, incremental innovation and a number of targeted high-impact projects. To implement this ambition:

- The Commission will look at ways to strengthen existing bottom-up approaches to innovation under Horizon 2020 and explore other mechanisms, including a potential European Innovation Council. This will help to better support potentially disruptive technologies, innovations, and business models, including breakthrough innovations for the low-carbon economy which are not foreseen in strategic, mission-driven funding.
- The Commission intends to deploy more than EUR 2 billion from the Horizon 2020 work programme for 2018-2020 to support research and innovation projects in four priority areas: (1) Decarbonising the EU building stock by 2050: from nearly-zero energy buildings to energy-plus districts; (2) Strengthening EU leadership on renewables (RES); (3) Developing affordable and integrated energy storage solutions; and (4) Electro-mobility and a more integrated urban

³⁷ See, High RES scenario, in: *Impact Assessment of Roadmap 2050*, SEC(2011) 1565/2, Part ½.

³⁸ Current EU support for storage-related R&I is provided mainly as part of the smart-grids activities of the SET Plan and in the context of the Fuel Cells and Hydrogen Joint Undertaking.

³⁹ See, *Communication on a European Strategy for Low-Emission Mobility*, COM(2016) 501 final.

transport system. This represents a 35% budget increase in annual terms from 2014-2015 levels in these four areas.

- The Commission will reinforce the support provided from ESIF through the thematic Smart Specialisation Platforms, notably the ones on energy and industrial modernisation, as a springboard for regional innovation and industrial clusters to work on concrete investment projects in areas such as digital and key enabling technologies and energy efficiency. The four priority areas will be further targeted, mobilising public and private stakeholders in synergy with other EU instruments and funding schemes.
- In the context of the existing Horizon 2020 funding instruments and rules, the Commission will set up a pilot scheme combining a directive, mission-driven approach to identifying and selecting projects with high potential impact; direct involvement in the day-to-day management of the project and various forms of targeted, tailor-made assistance; as well as existing powers to restructure or terminate funding if agreed milestones are not reached. The scheme will emphasize quick impacts and market relevance reached.
- The Commission intends to launch a flagship Energy Innovation inducement Prize for EUR 5 to EUR 10 million to reward a breakthrough innovation, for example in one of the following areas: (1) Artificial photosynthesis; (2) Low cost, nearly-zero energy building (NZEB) design and construction; (3) Community-based energy trading scheme; or (4) Social innovation in energy and/or transport at city level.

6. LEVERAGING EUROPE'S GLOBAL ROLE

In line with the Commission's priority to be a stronger global actor, Europe needs to draw greater value from its role as global climate champion and pioneer of low-carbon and energy-efficient solutions, to ensure that it remains at the centre of global value chains, with associated benefits for its manufacturing industry and worldwide exports. Climate finance and the implementation of national commitments are stimuli for global technology cooperation and to create market opportunities for European businesses. The Paris Agreement underlines the role of research and innovation, in particular in cooperation with developing and emerging economies, based on systemic observation.

Growing global energy needs, in particular in emerging markets, present significant export opportunities for European companies to supply low-emission technologies, including, where applicable, 'frugal' innovations that are adapted to local conditions. New strategic partnerships, especially with emerging economies, are needed to drive innovation and create markets.

Close cooperation with international partners is of high strategic value. This has been underlined by the decision of the European Commission in 2016 to join, on behalf of the EU, the Mission Innovation⁴⁰ initiative that was launched at COP 21. Currently 22 countries (of which eight are EU Member States) and the EU are members, committed to doubling their public clean energy research funding over five years. Mission Innovation will help reverse the decline in public expenditure for clean energy research, which is still

⁴⁰ Press release, 3 June 2016, European Union joins Mission Innovation, a global initiative on clean energy: http://europa.eu/rapid/press-release_IP-16-2063_it.htm

below its previous peak⁴¹ and far below the much higher levels needed to attain the goals of the Paris Agreement. Furthermore, it will align the focus of public expenditure with large private investors, for example through interaction with the Breakthrough Energy Coalition⁴². The EU will play a leading role in Mission Innovation and will have a specific focus realising synergies with the Breakthrough Energy Coalition. Mission Innovation members have identified seven Innovation Challenges which are critical to achieving a low-carbon society. The EU will lead the Converting Sunlight Innovation Challenge to create storable solar fuels and the Affordable Heating and Cooling of Buildings Innovation Challenge. It will participate actively in the other Innovation Challenges, in close cooperation with other Mission Innovation members.

Through international outreach, strengthening strategic research partnerships and exchanging knowledge, expertise, technology and qualified personnel with key countries, the European Commission will continue to support developing and emerging countries in their energy transition, thereby contributing to the implementation of the Sustainable Development Goals (notably number 7 "Affordable and clean energy" and number 13 "Climate Action"). In particular, the recently adopted proposal for a European External Investment Plan with its European Fund for Sustainable Development⁴³, aims to attract private investment to African countries, which can be of crucial importance in rolling out low-carbon energy infrastructures and supporting innovative energy solutions. These activities will be closely linked to Europe's international climate, trade and development cooperation. Similarly, the EU will use its trade policy instruments and related technical assistance to encourage third countries to adopt climate-neutral solutions.

The European Commission is active on several fronts to help ensure that European research and innovation are 'Open to the World'⁴⁴. Following this approach, Horizon 2020 targets researchers and innovators from developing countries to work side-by-side with Europeans in developing those low-carbon energy technologies and solutions that are best suited to local circumstances. This will boost market opportunities for EU companies and help EU exports, as well as strengthen the capacities of developing countries and harvest the benefits of international scientific collaboration in bringing new technologies to market.

The Enterprise Europe Network, created in 2008 to help small and medium-sized enterprises to make the most of business opportunities in the EU and beyond, should also provide further support for EU business developing innovative clean energy solutions thorough an extended scope.

Leveraging Europe's global role – Proposed actions:

- The Commission will work with Member States such that the European Union plays a leading

⁴¹ Public energy RD&D spending in IEA member countries, OECD/IEA (2015).

⁴² The Breakthrough Energy Coalition is a group of more than 20 investors from different countries who launched an initiative jointly to Mission Innovation with the aim of investing in the clean energy research

⁴³ See COM/2016/0581

⁴⁴ See Open innovation, open science, open to the world, 2016, European Commission, ISBN 978-92-79-57346-0.

role within the global Mission Innovation initiative. It will lead the Converting Sunlight Innovation Challenge to create storable solar fuels and the Affordable Heating and Cooling of Buildings Innovation Challenge, and take an active part in the remaining innovation challenges. The Commission will focus on realizing synergies with the private sector including the Breakthrough Energy Coalition.

- The Commission will work with Member States to launch one or two joint deployment programmes in developing countries in the areas of energy efficiency and renewables, with a focus on Africa as a privileged partner in view of the EU-Africa summit in 2017. Such programmes will couple research and innovation with capacity building in the host country as both components are indispensable elements for reaching success on the ground. The EU financial contribution will consist of contributions originating from Horizon 2020 and/or Development cooperation programmes as appropriate. The initiative will be complemented by technical assistance where needed.
- The Enterprise Europe Network will be extended to additional third-country markets to facilitate business cooperation, technology transfer, knowledge transfer and research project cooperation for Small and Medium Enterprises, with the environment, renewable energy and sustainable construction as the most important sectors.

7. KEY ACTORS IN THE ENERGY TRANSITION

To create sustained impact and ensure uptake of the innovative solutions that will be supported by the Commission through this strategy, citizens, cities, regions and Member States all play a crucial role.

Citizens are central to the successful uptake of low-carbon innovative solutions, from smart meters in their homes to large-scale wind farms. Finding new and better ways to involve Europe's citizens in the low-carbon transition and to give voice to existing high levels of popular support is of critical importance. More involved citizens take greater responsibility for their own and the EU's energy security, and they help devise novel and original business models.

Regions and urban areas are most suitable for testing and implementing integrated innovative solutions in direct connection to citizens. Building on the specific support to regions and cities of the EU's regional policy, the Urban Agenda for the EU and now following Habitat III the global New Urban Agenda, the Global Covenant of Mayors,⁴⁵ the European Innovation Partnership on Smart Cities and Communities, and the CIVITAS network⁴⁶, Europe's cities, towns and regions have been instrumental in promoting ownership of the energy transition and in pushing climate and energy-related innovation from below. In addition, networks of neighbourhoods, cities and regions can help to share best practices and pool resources and investments. In this respect the support provided through the smart specialisation platforms and Horizon 2020 for smart and sustainable cities, needs to be expanded to incorporate inclusive city aspects to further develop the results achieved. Initiatives such as the Horizon 2020 Smart and Sustainable Cities focus

⁴⁵ See, http://www.covenantofmayors.eu/index_en.html.

⁴⁶ CIVITAS is designed as a programme that allows cities to learn from each other and facilitate exchange of ideas

area, the Joint Programming Initiative Urban Europe and the Urban Innovative Actions,⁴⁷ as well as the European Innovation Partnership for Smart Cities and Communities, should be systemically streamlined and scaled-up in order to stimulate the further development and uptake of low-carbon, energy-efficient solutions across all sectors of urban society. Better measurement and sharing of data, as well as the development of more interoperable systems and associated data security and privacy guarantees, is critical for this to take place.

Through their established innovation-linked urban eco-systems ('smart cities'), investment platforms to aggregate small-scale energy-efficiency or renewable-energy projects, and work towards more eco-friendly urban transport solutions cities are indispensable to support the uptake of clean energy innovations that are promoted through the actions of this Communication.

In addition to cities and regions, Member States are crucial in advancing the energy transition. Various mechanisms exist to coordinate the EU's energy-related research and innovation activities with those of its Member States, or to better align public-sector support with that provided by the private sector. Yet, there is room for more efficiency and for realising greater synergies.

The Strategic Energy Technology Plan, which includes 28 Member States and four associated countries, as well as industrial and academic stakeholders, is a core part of the governance structure of the Energy Union. Coordinating their respective activities and creating greater synergies, the Strategic Energy Technology Plan has facilitated a doubling of annual total research & development investment in Strategic Energy Technology Plan priority technologies in the past few years. Joint research and innovation targets have been set in ten priority action areas, to further step up coordinated or joint investments, reflecting a growing level of commitment. Analogously, in transport, the Strategic Transport Research and Innovation Agenda is being set up, structured around the development of seven expert roadmaps and a corresponding governance mechanism to support and speed up research, innovation and deployment. Both the Strategic Energy Technology Plan and the Strategic Transport Research and Innovation Agenda will provide important structures for coordination with the actions described in this Communication, supporting their implementation and creating synergies to achieve impact.

⁴⁷ <http://www.uia-initiative.eu/>

Key actors in the energy system - Proposed actions:

- The Commission will work with Member States through the Energy Union governance structures, and in particular through the SET Plan, to align Member State investments under the four priority areas mentioned in Section 5 and to explore possibilities for developing relevant Important Projects of Common European Interest.
- The Governance of the Energy Union will ensure that the national objectives and measures regarding research, innovation and competitiveness, are set out in national integrated energy and climate plans and that objectives, policies and measures are coherent with the EU's objectives. In addition, biennial integrated progress reports and the State of the Energy Union reports will ensure the necessary follow-up and monitoring.
- The Commission will set up a specific governance structure with Member States on Strategic Transport Research and Innovation Agenda, to align strategic plans for long-term transport research and innovation actions and to better link them to the energy sector and digital technologies.
- The Commission will stimulate sharing and upscaling of best practices and smart, sustainable and inclusive urban demonstration projects, including those supported under the European Innovation Partnership on Smart Cities and Communities and under Urban Innovative Actions. This will also draw on data and products from the European Commission's Copernicus programme for Earth observation.

8. CONCLUSIONS

The policy measures set out in this document constitute the core of the research and innovation pillar of the Energy Union. They form an integral part of the broader package of "facilitating measures" needed to boost the clean energy transitions, which are outlined in the "Clean Energy for All Europeans" Communication issued today. The Commission will strive to implement these measures during the remainder of its mandate and will report on progress made in the framework of the annual State of the Energy Union.